UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
SAM NUNN ATLANTA FEDERAL CENTER
61 FORSYTH STREET SW SUITE 23T85
ATLANTA, GEORGIA 30303-8931

August 4, 2000

Virginia Electric and Power Company
ATTN: Mr. D. A. Christian
Senior Vice President-Nuclear
Innsbrook Technical Center
5000 Dominion Boulevard
Glen Allen, VA 23060

SUBJECT: NRC INSPECTION REPORT NO. 72-002/2000-06

Dear Mr. Christian:

On July 12, 2000, the NRC completed an inspection at your Surry Power Station Independent Spent Fuel Storage Installation (ISFSI). The enclosed report presents the results of that inspection.

During the three day period covered in this inspection report, the conduct of activities at the Surry ISFSI was generally characterized by safety-conscious operations, sound engineering and maintenance practices, and careful radiological work controls.

Based on the results of this inspection, the NRC has determined that there were no violations or deviations identified.

In accordance with 10 CFR 2.790 of the NRC's "Rules of Practice," a copy of this letter and its enclosure will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/NRC/ADAMS/index.html (the Public Electronic Reading Room).

Sincerely,

**/RA/**

Edward J. McAlpine, Chief
Fuel Facilities Branch
Division of Nuclear Materials Safety

Docket No.: 72-002
License No.: SNM-2501

Enclosure: (See Page 2)
Enclosure: NRC Inspection Report

cc w/encl:
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| DATE | 8/7/2000 | 8/2/2000 | 8/2/2000 | |
| E-MAIL COPY? | YES NO | YES NO | YES NO | YES NO |

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Enclosure

REGION II

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|---|---|
| Docket No.: | 72-002 |
| License No.: | SNM-2501 |
| Report No.: | 72-002/2000-06 |
| Licensee: | Virginia Electric and Power Company (VEPCO) |
| Facility: | Surry Independent Spent Fuel Storage Installation |
| Location: | 5850 Hog Island Road<br>Surry, VA 23883 |
| Dates: | July 10-12, 2000 |
| Inspectors: | W. B. Gloersen, Senior Fuel Facilities Inspector (RII) |
| Accompanying Personnel: | M. J. Ross-Lee, Project Manager (SFPO)<br>G. P. Hornseth, Materials Engineer (SFPO) |
| Approved by: | Edward J. McAlpine, Chief<br>Fuel Facilities Branch<br>Division of Nuclear Materials Safety |

# EXECUTIVE SUMMARY

Surry Power Station Independent Spent Fuel Storage Installation (ISFSI)
NRC Inspection Report No. 72-002/2000-06

On May 31, 2000 at 0054 hours, a low pressure alarm was received at the Surry ISFSI for the Transnuclear (TN-32) cask number TN-32-01 at ISFSI pad location 2-3. Trouble shooting could not determine the source of the alarm and on June 2, 2000, the cask was returned to the station to perform additional testing. On June 7, 2000 at 1755 hours, it was determined that a seal leak did exist and the licensee made a four-hour notification pursuant to 10 CFR 72.75(b)(2). On June 8, 2000 the cask lid secondary seal was identified as the cause of the leak. The primary seal continued to perform its intended function and there was no leakage from the cask cavity. The cask was placed in the spent fuel pool and the lid was removed to replace the lid seal. Upon lid removal, corrosion was found on the cask lid and body extending to the point of the secondary seal. The fuel was unloaded to allow rust removal and painting of the affected area of the cask flange and lid. An examination of the cask seal found that a preliminary cause of the secondary seal failure was corrosion. At the time of this inspection, an ongoing root cause evaluation was underway to determine the cause of the seal failure and recommend corrective actions. The licensee was in the process of formulating the corrective actions to prevent recurrence.

This special inspection included a review of certain aspects of the licensee's operations, engineering, and maintenance of the Transnuclear Model TN-32 dry cask storage system (DCSS). Specifically, this inspection involved a review of a TN-32 cask lid secondary seal leak. The report covers a three day period of inspection activities performed by representatives from the Spent Fuel Project Office and RII's Division of Nuclear Materials Safety.

## Design Control of ISFSI Components

- The licensee's root cause team provided a plausible determination that was consistent with the observations and probable contributing factors. The proposed corrective actions emphasized the exclusion of water and any associated corrosive species. This was the most effective corrective action proposed since it would also eliminate any potential deterioration of the structural parts of the cask, including the flange, lid and bolts (Section 1.2.c).

## Operation of an ISFSI

- The licensee's management oversight was effective and directly involved in the decision-making process to re-load the TN-32-01 cask (Section 2.1.c).

- The licensee had adequately identified and inspected each fuel assembly placed in the TN-32-01 cask. In addition, the licensee had recorded the parameters and characteristics of each fuel assembly and maintained a record of each fuel assembly (Section 2.1.c).

- The licensee had performed spent fuel loading activities in a safe manner and in compliance with approved procedures (Section 2.1.c).

Attachment: (See Page 2)

Attachment
Partial List of Persons Contacted
Inspection Procedures Used
List of Acronyms

# REPORT DETAILS

## Summary of Plant Status

During this inspection period, the licensee had initiated the re-loading of a Transnuclear (serial number TN-32-01) cask. The spent fuel in this cask had been off-loaded on June 15, 2000, due to the presence of corrosion found on the cask lid and body, and to facilitate lid repairs. The presence of corrosion was found on the cask lid and body extending to the point of the secondary seal. The licensee was in the process of performing a root cause investigation.

## 1. Design Control of ISFSI Components (60851)

### 1.1 General Comments

#### System Description

The Transnuclear Dry Storage Cask TN-32 design utilizes a double metallic O-ring confinement seal on the cask lid and the two cask lid penetrations. The double seal system allows the TN-32 cask to use a pressure monitoring system on the space between primary inner O-ring seal and the secondary outer O-ring seal. After the fuel is loaded into the cask, pressure in the space between the seals is set at approximately 5500 mbar while the internal cask cavity is set at approximately 2230 mbar. A decrease in the pressure of the monitoring system would be signaled by a pressure switch on the Over pressure (OP) System. The set point on the pressure switch is 3250 mbar. A protective environmental cover is secured on top of the cask to provide weather protection for the closure lid and seal components.

#### Event Description

The TN-32-01 cask was initially loaded at Surry in December 1996 with thirty-two Westinghouse 15X15 PWR spent fuel assemblies and placed at ISFSI pad location 2-3. On March 21, 2000 and on April 20, 2000, a low pressure alarm was received at the Surry ISFSI pad (location 2-3) for TN-32-01 cask. During both events, a 30-day administrative clock was entered to either correct the alarm condition or move the cask to the spent fuel pool and unload the fuel. In March, after trouble shooting at the ISFSI pad, the cause of the alarm was determined to be a stem and diaphragm leak from pressure switch(s) on the OP System. The switch(s) were replaced, the OP System re-pressurized, and the thirty-day administrative clock was exited. On May 31, 2000 at 0054 hours, another low pressure alarm was received on TN-32 cask 2-3. A thirty-day administrative clock was entered. Testing conducted at the ISFSI pad could not determine the source of the leak and on June 2, 2000, the cask was returned to the station to perform additional testing. On June 7, 2000 at 1755 hours, the licensee determined that a seal leak did exist and a four-hour notification was made pursuant to 10 CFR 72.75(b)(2).

On June 8, 2000 test results indicated that the source of the leakage appeared to be the cask lid secondary O-ring seal. On June 15, 2000 the cask was placed in the spent fuel pool and the lid was removed. Corrosion was found on the cask lid. To facilitate repairs to the lid, and to allow more extensive examination of the cask body, the decision was

made to unload the fuel and remove the cask from the spent fuel pool. An examination of the cask after the fuel was removed indicated the presence of corrosion on the cask lid and areas on the cask surface near the lid, extending to the point of the secondary O-ring seal. The seal was removed and the cask and lid sealing surfaces were examined. No indications of leak paths were found on the cask and lid sealing surfaces. The O-ring seal was examined and corrosion was found on the aluminum jacket of the secondary seal O-ring. The secondary seal O-ring aluminum jacket was pitted and had one indication of a through-wall leak. No corrosion was found on the primary seal. Sections of the seal were removed for further testing.

Radiological surveys conducted at the ISFSI pad by the licensee confirmed that radiation levels on the cask were normal. The internal pressure of the cask cavity was verified to be within Technical Specifications requirements. Test results indicated that the primary O-ring seal continued to perform its intended function and there was no leakage from the cask cavity. Therefore, there were no safety consequences or implications from the secondary cask seal leakage.

The licensee noted previous similar events between August 12 and 16, 1999, when an intermittent low pressure alarm was received at the Surry ISFSI pad for the Castor X/33 cask 1-24. On August 19, 1999 it was determined that the leak rate from the secondary lid seal was in excess of TS requirements. The secondary seal was replaced and sections of the seal were sent to the vendor for analysis. A final report is expected from the vendor and will complete the evaluation of the seal.

1.2 TN-32 Secondary Seal Leak

a. Inspection Scope

The inspectors examined the licensee's root cause determination and reviewed the proposed corrective actions in regards to a secondary seal leak on a Transnuclear TN-32 spent fuel storage cask (TN-32-01).

b. Observations and Findings

The secondary seal used in the TN-32 lid assembly was a metallic O-ring. The O-ring was composed of a Nimonic 90 spring enclosed in an Inconel 600 sleeve. The spring and sleeve assembly was enclosed inside a soft grade 1050 or 1100 aluminum cover which formed the malleable sealing surface. This O-ring sits just inside the bolt circle of the cask lid assembly.

The lid assembly, with associated cask and seal pressure monitoring equipment were all enclosed inside a water-tight weather cover consisting of a formed steel dome and rubber O-ring seal. The purpose of the weather cover was to preclude water from the lid bolts and the instrumentation installed on the lid.

The licensee opened the fuel storage cask upon discovering a leak associated with the secondary seal. Inspection of the cask lid revealed noticeable corrosion in the gap between the lid and the cask flange. The corrosion, observable as rusting of the carbon steel of the lid and flange, encompassed an area of about seven of the lid bolts (out of a

total number of 48 lid bolts). Inspection of the metallic O-ring revealed the aluminum jacket to be pitted in several places within this area. The licensee established a root cause and corrective actions team to investigate the nature of the corrosion and consider corrective actions. These activities were ongoing at the time of the inspection.

The licensee's (corporate) metallurgist provided a synopsis of the pitting corrosion observed in the seal material and the general corrosion (rusting) of the lid and flange. Photomicrographs of O-ring sections were displayed that confirmed the pitting nature of the aluminum corrosion. The aluminum pitting was concluded to be at least partially galvanic due to the combination of different metals in the area of the seal. Chemical tests of residues and corrosion product to determine the presence of any potentially aggressive species such as chlorides (from the coastal environment) were still pending.

The licensee's root cause team reported that rain water had been observed leaking in through an instrumentation conduit penetration on the top of the weather cover. The conduit fitting was discovered to be loose, thereby providing a leak path. The licensee also considered that moisture could have entered the weather cover area by means of the attached conduit. Any condensed moisture entering this way would become trapped under the weather cover.

There were several corrective actions under consideration. The primary emphasis of the corrective actions was the exclusion of water by means of a weather lid redesign. Under consideration, was the mounting of the pressure monitoring system on the side of the cask, outside of the protective cover. This will preclude the need for a Conax® connector on the top of the cover. This is the design currently in place under the general license. Additional modifications under consideration to be incorporated with the lid redesign were:

- Filling the area inside the weather lid with dry nitrogen to preclude condensation
- Painting the underside of the protective cover on casks in production
- Change of O-ring material to more resistant material such as stainless steel or silver
- Flame spray aluminum the entire lid flange on future casks to prevent rust formation

Repairs to the affected portions of the cask flange and structural lid were minor. The rusted areas were cleaned to bare metal with abrasive pads and needle gun. The carbon steel areas were then re-coated to original specifications with an epoxy paint. The O-ring grove and seating area was a stainless overlay and was unaffected. This surface was not coated. The inspectors reviewed for consistency the coating work order (number 00432224), coating manufacturers technical bulletins, and coating procedure (Procedure GMP-C-110, Revision 6). The coating repair work package was found to be clear, concise, and complete. The corporate coating procedure was found to be a model document for clarity and thoroughness.

In addition, the inspectors noted that the licensee was in the process of developing schedules to inspect all currently loaded TN-32's at Surry. The licensee also plans on using the modified protective covers for all TN-32's currently loaded at both the Surry and North Anna Plants.

The licensee was also looking at replacing the current pressure switches with more reliable ones that will not drift as has been observed on the current switches. Under consideration was a pressure transmitter with a remote readout. Nine out of the ten switches the licensee had inspected had drifted low.

c. Conclusions

The licensee's root cause team provided a plausible determination that was consistent with the observations and probable contributing factors. The proposed corrective actions emphasized the exclusion of water and any associated corrosive species. The inspectors found this was the most effective corrective action since this would also eliminate any potential deterioration of the structural parts of the cask (flange, lid and bolts).

## 2. Operation of an ISFSI (60855)

2.1 Re-Loading of Transnuclear TN-32-01 Spent Fuel Cask

a. Inspection Scope

The inspectors reviewed selected portions of the licensee's re-loading of the TN-32-01 dry storage cask, including an internal operational readiness review process and pre-loading fuel inspection.

b. Observations and Findings

The inspectors reviewed the following licensee procedures for ISFSI fuel inspection, selection, and certification:

- NAF-208, ISFSI Fuel Selection and Certification, Revision 9, January 28, 2000.
- NAF-202, Documentation and Disposition of Nonconforming Fuel, Insert Components, and Storage Casks, Revision 13, May 9, 2000.
- NAF-221, Irradiated Fuel Assembly and Insert Component Inspection, Revision 4, May 9, 2000.
- Fuel Accountability and Inspection Manual, Chapter 3, Section B, Part 3, Irradiated Fuel Inspection, Revision 9, May 2000 (Corporate Inspection Manual)

The inspectors verified that the licensee performed inspections of the off-loaded fuel, in accordance with the applicable procedures noted above, prior to initiating re-loading activities. The licensee identified an anomaly or "blemish" on one of the fuel elements of

an assembly that was to be re-loaded into the TN-32-01 cask. The licensee suspected that the "blemish" may have been caused either during initial fuel loading on December 12, 1996, or when the fuel was off loaded on June 15, 2000. In any event, the licensee elected not to re-load the fuel assembly with the "blemish" and selected another assembly in accordance with NAF-208. The licensee indicated that further evaluation of the affected assembly would be necessary before a decision would be made to re-load it into the next cask. The licensee documented the fuel assembly inspections on an Irradiated Fuel Assembly and Insert Component Visual Inspection Form and on a Fuel Assembly Video Inspection Form.

The inspectors also verified that the licensee completed the appropriate certification, in accordance with NAF-208, which identified the storage cask and the associated fuel assemblies to be loaded. The certification was transmitted to the Surry Power Station from the licensee's Innsbrook Technical Center in the form of a memo dated July 10, 2000. Basically, the certification provided assurance that the fuel assemblies and insert components to be stored in cask TN-32-01 meet the Surry ISFSI Technical Specification limits and the TN-32 TSAR limit for fuel rod internal pressure. The certification also included the cask loading map.

The inspectors attended a Station Nuclear Safety Operating Committee (SNSOC) meeting on July 10, 2000, where the licensee discussed the status of operational readiness to re-load the TN-32-01 cask to SNSOC members. During the meeting, the licensee presented a justification for re-loading the TN-32-01, as summarized below:

- Cask material condition issues resolved
  - Lid seal surface was examined and cleaned
  - Rust was removed from cask lid and lid was re-coated
  - Rust was removed from the protective cover and re-coated
  - Re-coating included the underside of the cover flange which was not originally coated
  - Protective cover viton O-ring was replaced

- Lid seal system testing completed
  - Lid seal system was tested satisfactorily without fuel with leak rate less than 1 E-05 mbar-1/second
  - New O-ring was installed on the cask

- Water ingress protection issues were resolved by replacing the Conax connector

- O-ring integrity issues resolved
  - A new O-ring was installed on the cask lid
  - Water ingress was expected to be minimal with replaced Conax connector
  - A new surveillance procedure will be developed with amended Technical Specifications
  - Over pressure (OP) system and pressure switches will have periodic surveillance requirements
  - A design change request for the protective cover will be initiated

- Upon approval of the design change, new protective covers will be installed on all TN-32 casks

The SNSOC ultimately granted approval to re-load the TN-32-01, however, the SNSOC requested that the root cause determination be completed by the end of July 2000. In addition, the SNSOC requested that the other TN-32 casks be inspected before the root cause analysis is complete.

The inspectors observed selected portions of the re-loading of the TN-32-01 cask, including the loading of four fuel assemblies into the cask; placement of the primary cask lid; and cask lifting and de-watering operations. The inspectors verified that the licensee was following the cask loading and operating procedure O-OP-FH-062, TN-32 Cask Loading and Handling, Revision 9. A current copy of the operating procedure was located near the area of operations in the Fuel Handling Building. O-OP-FH-062 made use of sign-offs to ensure that operations were performed as required. The inspectors verified that the operators had properly completed the required sign-offs in O-OP-FH-062. During the operational activities, acceptable radiological control practices were observed. Overall, the operational activities that were observed were performed safely, efficiently, and flawlessly.

c. Conclusions

The licensee had adequately identified and inspected each fuel assembly placed in the TN-32-01 cask. In addition, the licensee had recorded the parameters and characteristics of each fuel assembly and maintained a record of each fuel assembly.

The licensee's management oversight was effective and directly involved in the decision-making process to re-load the TN-32-01 cask.

The licensee had performed spent fuel loading activities in a safe manner and in compliance with approved procedures.

## 3. Exit Meeting Summary

The inspection scope and results were discussed with the licensee's staff throughout the reporting period. A summary of the issues were presented on July 12, 2000, to those persons indicated in the attachment. Although proprietary documents and processes were occasionally reviewed during this inspection, the proprietary nature of these documents or processes has been deleted from this report. No dissenting comments were received from the licensee.

# ATTACHMENT

## 1. PERSONS CONTACTED

Partial List Of The Licensee's Persons Contacted

J. Beck, In-Service Inspection Materials Engineer
*W. Benthall, Procedures
*R. Blount, Manager, Operations & Maintenance
W. Bracey, Nuclear Engineer (Transnuclear)
*T. Brookmire, Nuclear Analysis and Fuels
*M. Crist, Superintendent, Operations
*K. Ewell, Fuel Handling and Operations
*M. Gabriele, Operations
*B. Garber, Licensing
*J. Helm, Station Nuclear Safety
R. Robins, Nuclear Analysis and Fuels
*T. Sowers, Manager, Station Safety & Licensing
M. Small, Station Nuclear Safety
L. Spain, In-Service Inspection Materials Engineer
B. Speckine, Fuel Handling and Operations
*B. Stanley, Supervisor, Licensing
*C. Steinert, Licensing
*E. Turko, Nuclear Analysis and Fuels

*Denotes those in attendance at the exit meeting on July 12, 2000

## 2. INSPECTION PROCEDURES USED

60851 Design Control of ISFSI Components
60855 Operation of an ISFSI

## 3. LIST OF ACRONYMS USED

| | |
|---|---|
| CFR | Code of Federal Regulations |
| DCSS | Dry Cask Storage System |
| ISFSI | Independent Spent Fuel Storage Installation |
| ISI | In-Service Inspection |
| NAF | Nuclear Analysis and Fuels |
| OP | Over Pressure |
| PWR | Pressurized Water Reactor |
| SNSOC | Station Nuclear Safety Operating Committee |
| TN | Transnuclear |
| TS | Technical Specifications |
| TSAR | Topical Safety Analysis Report |